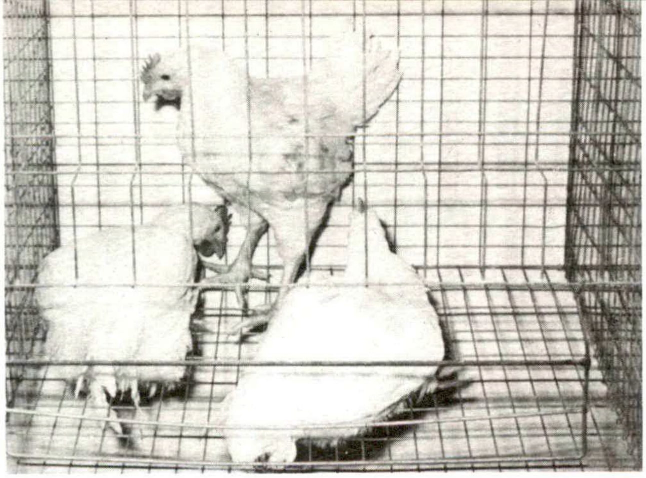
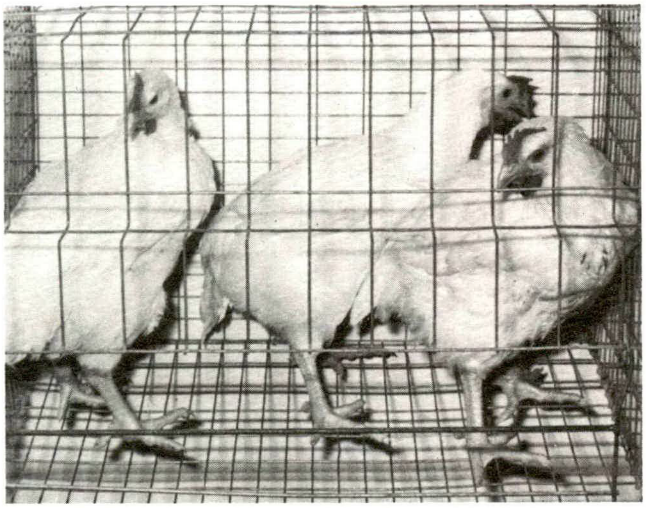
1975

Seventh Annual Poultry Field Day

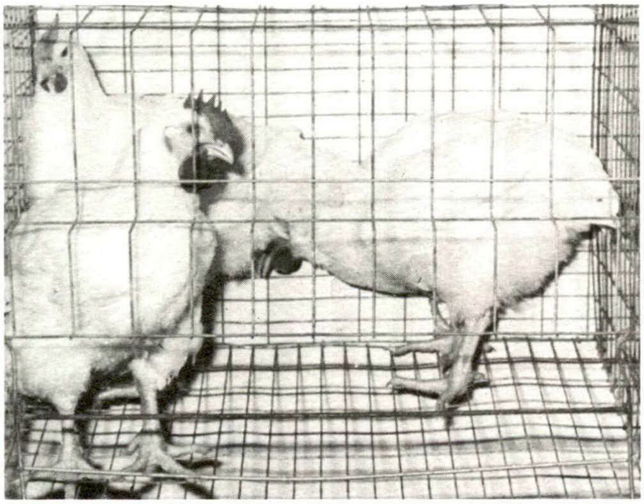
Animal Science Department
South Dakota State University



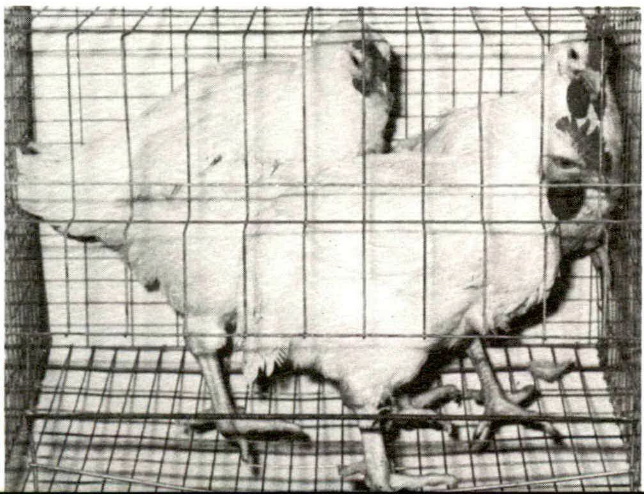
1776—8 weeks



1876—8 weeks



▲ 1926—8 weeks—1976 ▼



Seventh Annual

Poultry Day

Thursday, November 6, 1975
Staurolite Inn, Brookings, S. D.

Registration 10:00 a.m.

Research Reviews 10:30 a.m.

Educational Session 1:30 p.m.

Awards Banquet 6:30 p.m.

South Dakota 1976

USA BICENTENNIAL

© S.D. Bicentennial Commission 1973

MT. RUSHMORE – SHRINE OF DEMOCRACY / USA BICENTENNIAL FOCAL POINT

South Dakota State University
Bicentennial Special Events Site

Poultry-Meats Section
Animal Science Department
Agricultural Experiment Station
Cooperative Extension Service
South Dakota State University, Brookings

Table of Contents

300 copies printed at an estimated cost of $2.40 each 10-75-5093

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-27

Summary of Costs and Income of Layer Flocks on the SDSU Record Program

Phillip E. Plumart[1]

Summaries of the income and flock performance of all 19 flocks closed on the program for this year are included in A.S. Series No. 75-40 entitled "Flock Record Summary." Only those flocks for which additional records were received will be covered in this report. Eight flockowners cooperating in the South Dakota State University Computerized Flock Record Keeping Program submitted operating costs, fixed costs and hired labor figures after their flocks were closed between July 1, 1974, and June 30, 1975.

The figures were submitted to the computer and a business analysis report for each flock was prepared for the flockowner. The report was divided into four sections--income, egg production costs, return to labor and management and flock performance.

The summarized data are compared to the data of 16 other flocks closed out between March, 1972, and July 1, 1973, and 9 flocks closed out between July 1, 1973, and June 30, 1974, as reported in A.S. Series 73-13 (October, 1973) and A.S. Series 74-24 (November, 1974). However, the discussion here will pertain only to the 1974-1975 flocks. The egg production costs section was divided into two parts--operating costs and fixed costs. The average figures and the range for the eight flocks are recorded in tables 1, 2 and 3. The size of each flock for 1974-75 averaged 8,932 birds. The average cost of producing a dozen eggs, excluding labor and management, was 33.41 cents. The average income per dozen for all eggs sold was 44.81 cents, which left the flockowners with a return of 11.40 cents per dozen for labor and management, down 2.34 cents from the previous year.

The initial pullet cost averaged $1.80, insurance and interest on pullets amounted to another 6.6 cents per pullet and salvage value for the old hens decreased the cost by an average of 18.7 cents per pullet, so that the net cost per pullet was $1.68. This is an increase of 23.3% over the previous year. The salvage value per pullet housed was down to 18.71 cents in 1975 from 33.90 cents in 1974, a 45% reduction. The net cost of the pullet was 7.31 cents per dozen or about 23% of the cost of production.

Feed accounted for about 70.7% of the cost of production as each dozen eggs took an average of 23.63 cents worth of feed. Feed conversion averaged 4.08 pounds of feed per dozen eggs with the cost of feed ranging from $103.02 to $131.13 and averaging $116.89 per ton.

---

[1]Associate Professor and Extension Poultryman.

The rest of the operating costs were maintenance, utilities, insurance on buildings and equipment and miscellaneous items that averaged 0.29, 0.51, 0.12 and 0.04 cents per dozen, respectively. Medication was not listed as a separate cost for most of these flocks.

The total operating costs of 31.95 cents per dozen were about 96% of the total cost for producing a dozen eggs excluding labor and management.

Fixed costs are high first costs but represent a very small part of the total cost of producing a dozen eggs. Fixed costs have been cut in half percentagewise as they were 9.83% of the total production costs in 1972-73, whereas in these data fixed costs amounted to 1.47 cents per dozen, about 4.4% of the total production costs for the flocks. Building and equipment depreciation each averaged 0.41 cents, interest on investment averaged 0.55 cents and taxes averaged 0.10 cents per dozen eggs.

Return to labor and management varied from a profit of 3.27 to 20.90 cents per dozen for all eggs sold (table 4). The high income flock used feed costing $131.13 per ton and averaged 81.76% hen-day production with an income of 46.26 cents for all eggs sold. The lowest income flock showed a $112.03 per ton feed cost, 64.81% hen-day production and received 42.53 cents per dozen for all eggs sold.

Table 1. Operating Costs of Layer Flocks on the South Dakota State University Flock Record Program, 1972-73[1], 1973-74[2] and 1974-75[3]

Factor	Average cost 1972-73	Average cost 1973-74	Average cost 1974-75	Range 1974-75
	$	$	$	$
Initial cost per pullet	1.6700	1.6278	1.8037	1.6000 - 2.1400
Insurance and interest/pullet	0.0872	0.0762	0.0664	0.0101 - 0.1261
Less salvage value/pullet	0.3400	0.3390	0.1871	0.1388 - 0.2793
Net pullet cost	1.4172	1.3650	1.6830	1.4351 - 2.0268
	¢/doz.	¢/doz.	¢/doz.	¢/doz.
Net pullet cost	6.53	6.18	7.31	5.46 - 9.18
Feed cost	14.08	22.25	23.63	13.92 - 30.40
Medication cost	0.02	0.00	0.04	0.00 - 0.28
Maintenance cost	0.11	0.24	0.29	0.04 - 0.67
Utilities cost	0.40	0.46	0.51	0.37 - 0.80
Insurance on bldg. and equip.	0.11	0.14	0.12	0.08 - 0.22
Miscellaneous costs	0.02	0.16	0.04	0.00 - 0.10
Total operating costs	21.26	29.43	31.94	24.07 - 39.66

[1]Sixteen different flocks.
[2]Nine different flocks.
[3]Eight different flocks.

Table 2. Fixed Costs of Layer Flocks on the South Dakota State University Flock Record Program, 1972-73[1], 1973-74[2] and 1974-75[3]

Factor	Average cost per dozen 1972-73	Average cost per dozen 1973-74	Average cost per dozen 1974-75	Range per dozen 1974-75
	cents	cents	cents	cents
Building depreciation	0.77	0.56	0.41	0.00 - 0.59
Equipment depreciation	0.82	0.72	0.41	0.00 - 0.74
Interest on investment	0.65	0.53	0.55	0.00 - 1.07
Taxes	0.08	0.11	0.10	0.05 - 0.29
Total fixed costs per dozen	2.32	1.92	1.47	0.05 - 2.32

[1]Sixteen different flocks.
[2]Nine different flocks.
[3]Eight different flocks.

Table 3. Operating and Fixed Costs for Layer Flocks on the South Dakota State University Flock Record Program, 1972-73[1], 1973-74[2] and 1974-75[3]

Factor	Average 1972-73	Average 1973-74	Average 1974-75	Range 1974-75
Flock size	9,101	9,409	8,932	3,137 - 15,210
	¢/doz.	¢/doz.	¢/doz.	¢/doz.
Total operating cost	21.26	29.43	31.94	24.07 - 39.66
Total fixed costs	2.32	1.92	1.47	0.05 - 2.32
Total production costs (excluding labor and mgmt.)	23.58	31.35	33.41	26.38 - 41.26
Average income	22.95	45.09	44.81	38.94 - 48.01
Return to labor and management	-0.63	13.74	11.40	3.27 - 20.90

[1]Sixteen different flocks.
[2]Nine different flocks.
[3]Eight different flocks.

Table 4. Range of Return Per Dozen to Labor and Management for Layer Flocks, 1972-73[1], 1973-74[2] and 1974-75[3]

Return 1972-73	Return 1973-74	Return 1974-75
cents/dozen	cents/dozen	cents/dozen
-4.40 to +6.06	6.20 to 17.87	3.27 to 20.90

[1]Sixteen different flocks.
[2]Nine different flocks.
[3]Eight different flocks.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-28

The Fatty Liver Hemorrhagic Syndrome (FLHS)

R. A. Nelson and C. W. Carlson[1]

Fatty liver hemorrhagic syndrome (FLHS) has become a major cause of mortality among caged laying hens. It was second (14%) to lymphoid leukosis as the cause of death in 1974 among those hens submitted to the diagnostic laboratory from this research station. The problem seems to be increasing with the increased use of high energy-low protein layer diets.

The disease is often characterized by a 20 to 25% increase in body weight along with a 25 to 30% decrease in egg production and an increase in mortality from excessive abdominal and liver fat leading to liver hematomas.

FLHS is hard to produce in the laboratory. A normal level of mortality from the disease usually occurs, but this level is not adequate for studying the cause of the problem. Workers at Michigan State developed a method of feeding that produces high levels of FLHS by forcing excess feed into the crop of the laying hen. We have adapted this method to make it possible to test different agents for their possible effects in decreasing the level of the disease. One experiment using the force-feeding technique has been completed and others are either under way or being planned.

In the first experiment, high energy (10% fat), corn-soybean diets were force-fed at about 125% of normal intake for five weeks to 72 hens. Biotin and choline alone and combined at twice the NRC recommended levels were supplemented to give four diets. Three commercial strains that had been grown on 10 or 12% protein diets were used to complete the factorial design. *Ad libitum* feeding of these diets is being utilized on another 308 laying hens with the same factorial design. This second experiment is scheduled to run the full 14-month laying cycle.

Body weight and liver data for the first experiment are shown in tables 1 to 3. No large differences occurred due to biotin or choline addition, but there was a decrease in lipid content and size of the livers due to choline. The overall lipid content of the livers was not as high as expected, since a 40 to 50% level is not any higher than had been shown in our previous work with these diets using *ad libitum* feeding. Strain 3 controlled their liver lipid content better than strain 1 or strain 2, but liver size was still large.

Further work is now under way to see if lower fat levels in the diet will produce a fatty liver more easily. Liver fat content may actually be decreased by a fat addition to the diet. A possible reason is that the bile required for fat absorption in the small intestine is produced from liver fat. Further work may actually show dietary fat additions to be a deterrent of FLHS.

---

[1]Superintendent, Poultry Research Center, and Professor and Leader, Poultry Research and Extension, respectively.

Table 1. Effect of Diet and Strain on Body Weight (kg)

	Protein of grower diet	Laying diet: Control[1]	Control + choline[2]	Control + biotin[3]	Control + choline + biotin	Avg.
Strain 1	10%	1.93	1.84	1.98	1.90	1.91
	12%	2.09	2.24	2.07	2.08	2.12
Strain 2	10%	1.98	1.94	2.04	1.91	1.96
	12%	1.92	2.03	1.87	2.18	2.00
Strain 3	10%	1.88	1.88	1.89	1.77	1.85
	12%	2.24	2.21	1.73	1.99	2.04
Average		2.00	2.02	1.93	1.97	

[1] 10% yellow grease in a 14% protein corn-soy diet.
[2] 1500 mg/kg.
[3] 1.1 mg/kg.

Table 2. Fat Content of Livers as Affected by Diet and Strain (Percent Moisture-Free Lipid Extract)

	Protein of grower diet	Laying diet: Control[1]	Control + choline[2]	Control + biotin[3]	Control + choline + biotin	Avg.
Strain 1	10%	41.5	49.5	50.6	48.5	47.5
	12%	61.5	50.7	57.9	43.5	53.4
Strain 2	10%	51.1	35.8	35.0	39.4	40.3
	12%	54.4	38.1	56.9	48.3	49.4
Strain 3	10%	40.9	43.0	41.4	35.4	40.2
	12%	37.9	34.0	47.4	43.7	40.8
Average		47.9	41.9	48.2	43.1	

[1] 10% yellow grease in a 14% protein corn-soy diet.
[2] 1500 mg/kg.
[3] 1.1 mg/kg.

Table 3. Effect of Diet and Strain on Relative Liver Weight (Percent Liver of Body Weight)

	Protein of grower diet	Laying diet: Control[1]	Control + choline[2]	Control + biotin[3]	Control + choline + biotin	Avg.
Strain 1	10%	2.9	3.4	3.5	3.6	3.4
	12%	3.8	3.3	3.6	3.1	3.5
Strain 2	10%	3.1	3.0	2.8	3.4	3.1
	12%	3.3	3.0	3.7	3.2	3.3
Strain 3	10%	3.1	3.4	3.6	3.6	3.4
	12%	2.6	3.3	3.4	3.3	3.2
Average		3.3	3.2	3.4	3.4	

[1] 10% yellow grease in a 14% protein corn-soy diet.
[2] 1500 mg/kg.
[3] 1.1 mg/kg.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-29

Amino Acid Additions to a Low Protein Corn-Soy Diet for Egg Production

A. B. Kashani and C. W. Carlson[1]

The study to be reported here was conducted to determine if the protein level of layer diets could be lowered from the commonly used 16% level to 12% without reducing the performance of hens. Thirty-six 24-week-old Babcock 300 pullets in groups of six were placed in cages and randomly assigned to each dietary treatment. The formulas for the basal diets are shown in table 1. The first treatment consisted of the 11.8% protein diet with the second treatment containing an additional 0.15% methionine hydroxy analogue. Treatments 3, 4 and 5 were obtained by cumulatively supplementing the diet of the second treatment with 0.2% L-lysine, 0.1% DL-tryptophan and 0.4% DL-isoleucine (table 2). Treatment 6 consisted of the standard 16% protein diet.

The data on average hen-day egg production, feed intake, feed efficiency, mortality and body weight changes for fifteen 28-day periods are presented in tables 3, 4 and 5. As shown in table 3, the 11.8% protein diet supported an average of 67% hen-day egg production as compared to 70% for the hens receiving the 16% protein diet. The combined addition of methionine and lysine depressed production to 61%. Tryptophan appeared to somewhat alleviate the depression effect caused by methionine and lysine, whereas isoleucine was ineffective in improving production. Similar trends were observed in feed efficiency expressed as kilograms of feed required to produce a dozen eggs (table 4). A significant reduction in feed efficiency was observed only when lysine was added to the low protein diet. The isoleucine addition improved feed efficiency to a level that was statistically comparable to that obtained from the basal low or high protein diets. Had larger numbers been used, hens on the latter diet would most likely have been shown to be superior in all categories, as they were for the amount of egg per gram of feed.

Further data showed that feed intake (table 4), egg shell thickness, interior egg quality, body weight changes and mortality (table 5) were not significantly affected by the dietary treatments. Amino acid concentrations of egg albumen showed that eggs produced from hens fed the unsupplemented low protein diet contained somewhat lower levels of lysine and glutamic acid. Concentrations of lysine, glutamic acid and arginine were slightly increased as a result of methionine and combined methionine and lysine additions.

The slightly superior performance of hens on the 16% protein diet indicated that there may be need for further amino acid supplementation of the 11.8% protein diet. This year's experiment, therefore, includes an additional treatment containing 0.25% DL-valine. Also, a 10% protein diet was formulated to be supplemented

---

[1]Graduate Assistant and Professor and Leader, Poultry Research and Extension.

with the above mentioned essential amino acids, since the performance of the birds receiving the unsupplemented 11.8% protein diet was surprisingly satisfactory. Three strains are being used in the present study to investigate genetic effects, since previous work had shown mediocre performance with a low protein diet similar to that used in the study reported here.

Table 1. Composition of Basal Diets

	Dietary protein (percent) 16.0	11.8
	Percent of the diet	
Ground yellow corn	71.0	82.0
Soybean meal (47% protein)	20.0	9.0
Alfalfa meal (17% protein)	2.0	2.0
Dicalcium phosphate	1.5	1.5
Limestone	5.0	5.0
Salt mix[1]	0.5	0.5
Vitamin mix[2]	+	+

[1]Contained in grams per kg of salt mix: sodium chloride, 920; zinc, 10.0; iron, 6.0; manganese, 4.0; copper, 0.8; cobalt, 0.15 and iodine, 0.07.

[2]Contained per kg of diet: vitamin A, 5,280 USP; vitamin D_3, 1,375 USP; vitamin E, 22 IU; vitamin B_{12}, 0.0088 mg; niacin, 44 mg; choline chloride, 440 mg; riboflavin, 6.6 mg; d-calcium pantothenic acid, 8.8 mg; vitamin K, 1.1 mg; folic acid, 1.1 mg and biotin, 0.11 mg.

Table 2. Amino Acid Supplementation of the Low Protein Diet

	Added amino acids as percent of the diet			
Treatment	Methionine hydroxy analogue	L-lysine	DL-tryptophan	DL-isoleucine
1 (11.8% protein)	--	--	--	--
2	0.15	--	--	--
3	0.15	0.20	--	--
4	0.15	0.20	0.10	--
5	0.15	0.20	0.10	0.40
6 (16.0% protein)	--	--	--	--

Table 3. Egg Production and Egg Weight

Treatment	Means of 15 periods: Egg production, Hen-day	Egg production, Daily	Average egg weight
	%	gm	gm
1 11.8% protein	66.79bc[1]	42.39ab	63.61a
2 As 1 + methionine	63.02ab	40.38a	64.36a
3 As 2 + L-lysine	60.76a	38.74a	63.98a
4 As 3 + DL-tryptophan	64.69ab	41.82ab	65.16a
5 As 4 + DL-isoleucine	63.20ab	40.57a	64.59a
6 16.0% protein	70.34c	45.18b	64.38a

[1]Data followed by unlike letters are significantly different (P>.05).

Table 4. Feed Consumption and Efficiency

Treatment	Means of 15 periods: Hen-day feed intake	Feed per dozen eggs	Amount of egg per gram of feed
	gm	kg	mg
1 11.8% protein	115.5a[1]	2.21ab	369a
2 As 1 + methionine	117.1a	2.32bc	347a
3 As 2 + L-lysine	114.0a	2.44c	343a
4 As 3 + DL-tryptophan	117.2a	2.37bc	359a
5 As 4 + DL-isoleucine	111.7a	2.21abc	368a
6 16.0% protein	112.6a	1.95a	405b

[1]Data followed by unlike letters are significantly different (P>.05).

Table 5. Mortality and Body Weight

Treatment	Mortality	Body weight: Initial	After 15 periods	Percent change
	%	kg	kg	
1 11.8% protein	7.4	1.53	1.72	+12
2 As 1 + methionine	7.4	1.51	1.74	+15
3 As 2 + L-lysine	9.8	1.50	1.78	+19
4 As 3 + DL-tryptophan	8.3	1.55	1.75	+13
5 As 4 + DL-isoleucine	17.6	1.52	1.70	+12
6 16.0% protein	12.2	1.55	1.76	+13

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-30

Moldy Feed - Good or Bad

George Semeniuk and C. W. Carlson[1]

Molds develop in feed in response to the nourishment they get from the feed. They develop only in the presence of air and as the result of favorable moisture conditions, which must be above a relative water vapor pressure equivalence of 65 to 70%. They develop very slowly at near-freezing temperatures and rapidly as temperatures rise. By enzyme action, they convert the energy components of the feed (carbohydrates, fats and proteins) into their own body structure with loss to the air mainly of metabolically-generated heat, water, carbon dioxide, ammonia and of fragments of their body as spores. They may or may not produce chemicals toxic to animals, which will remain with the mold in the feed. Their overall effect is to lower the total energy content of the feed, replacing some of it with their own body structure and by-products.

Despite the loss of total energy (i.e., feed weight loss) and barring the formation of toxic chemicals, the nutritive value of feed on a weight basis may remain unchanged or be improved by mold action if the process is stopped early. At the start, molds grow rapidly in response to the availability of readily utilizable nutrients and at that time their body tissue is young and most active enzymatically on the feed. Thereafter with the depletion of these nutrients, growth is slowed and proportionately more secondary and less nutritive changes take place in the composition of the mold body as well as in the feed.

Improvements in the nutritive value of moldy feed are largely the result of changes in the composition of its total protein. Mold protein can be up to 50% water soluble (as free amino acids and peptides) while feed protein is mainly water insoluble. Further, the relative proportion of various amino acids in the moldy feed usually is different from that in nonmoldy feed. This is believed to account for the improved growth and feed utilization efficiency that we got when we fed broiler chicks and Japanese quail molded soybeans at 50% of their diet. Similar benefits are believed to accrue to the oriental people who regularly consume controlled, mold-fermented soybeans called Tempeh, Miso, Sufu and other products as part of their regular diet.

Harmful or nonbeneficial effects of moldy feed usually are the result either of toxins generated by the molds or of significant reductions in the total energy value of the feed or a combination of both. Toxins may be chemically-characterized compounds generated by specific molds that happen to develop in the feed as the result of some unknown special condition, or they may be a conglomerate of fungal by-products from several molds that develop in the feed and render the feed unpalatable and indigestible. There are about 20 toxins of the first category that affect

[1] Professors, Department of Plant Science and Animal Science, respectively.

farm animals and man, producing such varied responses as liver and kidney lesions, internal hemorrhages, convulsions, vomiting, abortion, excess salivation, vulvovaginitis, and liver cancer. Those of the second category have not been characterized. Our test of 392 strains of 132 species of just one genus of mold (*Aspergillus*) commonly found in soil and in feed showed that nearly one-half of them when grown on wheat and soybeans were toxic to mice and/or chicks. Most of the others were neutral to these animals and a few strains were beneficial to growth.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-31

Changes in the South Dakota Egg Law Effective July 1, 1975
Chapter 39-11
Eggs and Egg Products

Boyd J. Bonzer[1]

The following is a listing of the South Dakota subchapter headings and a summary of the changes that were passed by the 1975 legislature.

Section

39-11-1. Definition of terms.--The following definitions were deleted from the law: Definition (2) "Container", (8) "Lots", (9) "Person", and (11) "Edible Restricted Eggs".

39-11-2. License required for egg dealing or processing--Exemptions.--This was rewritten with about the same meaning.

39-11-5. Annual fees for classes of licenses--License required to candle or grade.
- (1) Omit reference to vehicle license.
- (2) Omit class C license for producers with flocks of less than 3,000 layers.

39-11-6. Expiration and renewal of licenses--Late renewal fee.
- (1) Change candler and grader license due date to Feb. 28.
- (2) Added a $25.00 fee for late applications for renewal of licenses.

39-11-7-2. Sales not subject to shell egg regulations--Label of ungraded eggs. Repealed.

39-11-14. Possession of unfit eggs prohibited--Denatured egg products for animal foods allowed.
- (1) Omit reference to "edible restricted eggs".
- (2) Add--No person shall have eggs unfit for human consumption in his possession except egg products to be sold for animal feed that are denatured as prescribed by regulation.

39-11-17. Violation or noncompliance as grounds for revocation of license--Notice and opportunity to deny charges.--Notice of revocation of license changed from "as summons served in civil action" to "served by registered mail".

The following subchapters were not changed by the 1975 legislature.

39-11-4. Issuance of license in compliance with requirements--Examination for candler's license.

39-11-7. Regulations governing grading, production and distribution standards--Plant requirements--Enforcement.

39-11-7-1. Regulations governing sale of shell eggs to retailers and institutions.

---

[1]Extension Poultryman.

South Dakota State University
Brookings, South Dakota
Department of Veterinary Science

A.S. Series 75-32

Causes of Mortality in Poultry Submitted to the Animal Disease Research and Diagnostic Laboratory, July 1974 - June 1975

Martin E. Bergeland[1]

	Chicken	Turkey	Other
Amyloidosis	1		Goose - 1 Duck - 1
Aortic Rupture		1	
Aplastic Anemia	5		
Arizona Infection		1	Goose - 2
Aspergillosis		1	Goose - 2 Duck - 2
Avian Encephalomyelitis	3	1	
Botulism		1	Duck - 1
Cannibalism	15		
Chronic Respiratory Disease	5		Duck - 1
Cloacal Prolapse	2		
Coccidiosis	7	2	Pheasant - 1
Deficiency, Vitamin A	4		
Deficiency, Vitamin B	1	1	
Dehydration	1	2	
E. coli Infection	10	10	Goose - 1
Encephalomalacia, Nutritional	2		
Enteritis, Necrotic			Goose - 5
Exposure	1		
Fatty Liver	17		

---

[1]DVM, Professor of Veterinary Science.

	Chicken	Turkey	Other
Fowl Cholera			Duck - 1 Goose - 1 Pheasant - 1
Fowl Coryza	1		
Gout	1	1	Goose - 1 Partridge - 1
Hepatitis, Bacterial	1		Goose - 1
Impacted Oviduct	11		
Lymphoid Leukosis	29		
Marek's Disease	12		
Myopathy, Transport		4	
Osteodystrophy	20	7	
Osteomyelitis-Synovitis		7	
Parasites, Intestinal	2		
Perosis	4		
Reovirus Infection		1	
Round Heart Disease		4	
Salmonellosis	11	11	Goose - 2
Sinusitis		1	
Staphylococcosis	10		Duck - 2
Starvation	2	2	
Streptococcosis	3		
Trauma	3		
Tuberculosis	4		Pheasant - 1
Tumors, Miscellaneous	3		

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-33

Low Protein Pullet Grower Diets and Their Effects on Subsequent Reproductive Performance

R. A. Nelson and C. W. Carlson[1]

Numerous studies, including several at this station, have shown that layer-type pullets can utilize diets as low as 10 or 12% protein during the growing stage without affecting their subsequent reproductive performance. Past grower studies had been conducted using floor pens with corn-cob litter. A cage growing system was installed in the brooder building during the past year. Since commercial growing of layer-type pullets in cages is now becoming quite common, it was felt that the low protein diets should be tested under these conditions.

Eight replicates of 176 9-week-old pullets of three commercial strains were housed at the rate of 11 birds per cage (24" x 16") and fed two grower diets, 10% (1900 kcal ME/kg) or 12% (2900 kcal ME/kg) protein. The pullets had been started on a high energy, 20% protein, corn-soybean type diet. At 21 weeks of age they were placed in layer cages and data are now being collected on reproductive performance.

Two other experiments partially reported last year (Experiments 3 and 4, A.S. Series 74-9) have been completed and are included in this report.

Table 1 shows the data from the cage grower study. The 10% protein diet again produced slightly smaller birds for all three strains with the usual increase in feed consumption per bird. Birds of strain 2 gained somewhat better on both diets, resulting in improved feed efficiency. Mortality was low (about 2%) for this experiment.

Tables 2 and 3 show data from the completed reproductive cycles from last year's floor raised birds. No significant differences were found in hen-day production due to previous grower diet, strain or layer diet. Although not significant, the 14% protein layer diet was slightly less efficient than the 18 to 16% protein diets in both experiments. Layer diet had no effect on egg size in experiment 3, while the hens on the lower protein layer diet produced significantly larger eggs in experiment 4. Hens that were grown on the 10% grower diets produced significantly smaller eggs in both experiments, although the eggs were still excessively large. Birds of strain 3 appeared to produce smaller eggs, but the difference was not significant.

Mortality was quite high in both experiments, due primarily to cannibalism. Again, hens on the 10% grower diets showed less subsequent mortality, while hens on the lower protein layer diet appeared to have lower mortality, which is the opposite of past studies. Similar trends in mortality as affected by strain were shown in both experiments, with birds of strain 3 showing greater livability.

---

[1]Superintendent, Poultry Research Center, and Professor and Leader, Poultry Research and Extension, respectively.

The results of these two experiments indicate that modern layer-type pullets can tolerate low protein-low energy grower diets and subsequently live better and perform equally well on layer rations of low or normal protein content.

Table 1. Average Growth Performance of Pullets as Influenced by Grower Diet and Strain

Grower diet	Strain	Initial weight	Final weight	Gain	Feed/gain	Feed/bird
		kg	kg	kg	kg	kg
10-1950[1]	1	0.67	1.29	0.62	10.7	6.7
10-1950	2	0.66	1.38	0.72	10.0	7.0
10-1950	3	0.65	1.30	0.65	10.4	6.8
12-2900[2]	1	0.66	1.35	0.68	8.2	5.6
12-2900	2	0.65	1.44	0.79	7.3	5.8
12-2900	3	0.65	1.35	0.70	8.0	5.6

[1]10% protein, 1950 kcal of ME/kg from 9 through 20 weeks of age.
[2]12% protein, 2900 kcal of ME/kg from 9 through 20 weeks of age.

Table 2. Average Performance of Laying Hens as Influenced by Grower Diet, Strain and Layer Diet (Experiment 3, 1974)

Treatment	Hen-day production[1]	Feed per dozen eggs	Egg weight	Hen-housed mortality
	%	kg	gm	%
Grower diet[2]				
10-1950	72.5	2.01	65.0b[5]	12.5
10-1950+	70.8	2.12	64.1a	11.1
12-2900	69.9	2.14	65.3bc	15.3
12-2900+	66.7	2.26	65.7c	19.4
Strain				
1	68.8	2.33b	66.3b	19.8
2	72.6	2.03a	64.5a	13.5
3	68.6	2.04a	64.3a	10.4
Layer diet				
18-16[3]	70.8	2.07	65.0	15.3
14[4]	69.2	2.20	65.1	13.9

[1] Fifteen 28-day periods.
[2] 10-1950 = 10% protein, 1950 kcal of ME/kg.
10-1950+ = as above + 22 ppm Neomycin and Terramycin.
12-2900 = 12% protein, 2900 kcal of ME/kg.
12-2900+ = as above + 22 ppm Neomycin and Terramycin.
[3] 18% protein until 40 weeks of age, 16% thereafter.
[4] 14% protein + 0.1% methionine throughout.
[5] Means with unlike subscripts are significantly different ($P<.05$).

Table 3. Average Performance of Laying Hens as Influenced by Grower Diet, Strain and Layer Diet[1] (Experiment 4, 1974)

Treatment	Hen-day production	Feed per dozen eggs	Egg weight	Hen-housed mortality
	%	kg	gm	%
Grower diet[2]				
10-1950	65.4	2.14	63.5b[5]	12.0
10-1950+	66.8	2.07	63.6b	18.1
12-2900	66.3	2.08	64.1a	23.5
12-2900+	66.9	2.14	64.5a	22.9
Strain				
1	65.2	2.12	64.1	25.3
2	67.7	2.14	64.3	18.2
3	66.1	2.06	63.4	13.8
Layer diet				
18-16[3]	66.5	2.07	63.6b	21.3
14[4]	66.2	2.15	64.2a	17.0

[1]Fifteen 28-day periods.
[2]10-1950 = 10% protein, 1950 kcal of ME/kg.
10-1950+ = as above plus 22 ppm Neomycin and Terramycin.
12-2900 = 12% protein, 2900 kcal of ME/kg.
12-2900+ = as above plus 22 ppm Neomycin and Terramycin.
[3]18% protein until 40 weeks of age, 16% thereafter.
[4]14% protein and 0.1% methionine throughout.
[5]Means with unlike subscripts are significantly different (P<.05).

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-34

Feed Restriction with High and Low Energy and Protein Layer Diets

E. Guenthner and C. W. Carlson[1]

Current reports in the literature indicate that the feed cost of producing eggs can be reduced by limiting feed intake. This is true when laying diets of high nutrient density are used and the feed restriction is applied after the flock peaks in production. Previous tests at this station have shown that, under some feed cost situations, lower density diets also can reduce the feed cost of eggs. This experiment tested the effects of restricting both low and high density diets on hen performance.

The pullets were placed in laying cages at 22 weeks. The laying diets were formulated to contain 13.9 and 16.0% crude protein. Each level of protein also was formulated to provide 2500 and 2900 Cal ME/kg of feed. Feed restriction was applied to one-half of the hens when they reached 50% production by covering the feeders. The feeders were covered each afternoon at 3:00 p.m. and uncovered the following morning at 8:00 a.m. The test lasted 15 months.

The main results of the test are shown in table 1. Egg production increased with each increase in protein level and also with each increase in energy level. Lower feed consumption was associated with the lower levels of dietary protein, which also was associated with the lowest rate of egg production. The poorest feed conversion was noted with the low protein-low energy diet. The least feed conversion was obtained with the 2900 Cal diets and either level of protein. There were no great differences in egg size due to protein-energy levels. The lowest mortality was associated with the low energy diets and increased mortality was associated with the higher level of energy.

Continuous feed restriction adversely affected rate of egg production, feed conversion and egg size. Restriction reduced feed intake an average of 6.6 gm or 6.1%. The effect of restriction on rate of production was most severe for the low protein-low energy diet and least severe on the high protein-high energy diet. Lower mortality was associated with feed restriction in three of four instances.

[1]Assistant Professor and Professor and Leader, Poultry Research and Extension.

Table 1. Effects of Protein-Energy Levels and Feed Restriction on Hen Performance

Crude protein, %		13.9		16.0		
Energy, ME/kg		2500	2900	2500	2900	Avg.
HDEP, %						
Full feed		62.7	64.2	62.1	65.6	63.7
Restricted		50.1	60.8	57.9	62.4	57.8
	Avg.	56.4	62.5	60.0	64.0	
Feed/day, gm						
Full feed		111.5	105.2	109.6	108.5	108.7
Restricted		98.3	102.2	104.2	103.7	102.1
	Avg.	104.9	103.7	106.9	106.1	
Egg weight, gm						
Full feed		64.2	63.0	63.6	64.4	63.8
Restricted		63.0	62.2	63.2	63.4	62.9
	Avg.	63.6	62.6	63.4	63.9	
Kg feed/doz.						
Full feed		2.1	2.2	2.2	1.9	2.1
Restricted		2.5	2.4	2.2	2.1	2.2
	Avg.	2.3	2.0	2.2	2.0	
Mortality, %						
Full feed		8.3	13.5	8.0	16.4	11.6
Restricted		6.3	14.9	5.0	11.4	10.5
	Avg.	7.3	14.2	6.5	13.9	

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-35

Low vs. High Protein Diets for Turkeys

E. Guenthner and C. W. Carlson[1]

Two series of corn-soy diets, one high in protein and energy (HPE) and the other low in protein and intermediate in energy (LPE), were fed to 600 male and 300 female Large White poults. The high protein diets, with supplemental methionine, started at 32% crude protein (CP) and were stepped down at 4-week intervals to 16% CP. The energy values of the HPE diets started at 3150 Cal M.E. per kg and were stepped up to 3525 Cal. The LPE diets, supplemented with methionine and lysine, started with 23% CP and were stepped down to 12% CP. The energy values of the LPE diets were held at 2800 Cal M.E. per kg for the duration of the test. The treatments also included three levels of copper, normal (8 to 12 ppm) and two levels of supplemental copper from $CuSO_4$ (60 and 120 ppm). The poults were grown intermingled, 50 males and 25 females in each of 12 pens. Crushed corn cob litter was used. The experimental period for the hens ended at 16 weeks, when they were removed from the flock, and the toms continued in the same pens through 24 weeks. The main responses to the treatments are summarized in table 1. The results of the feed density treatments shown were averaged over all of the copper treatments and are shown in table 2. Similarly, the copper treatments were averaged over the feed density treatments. This was done to bring out the main effect of any treatment independent of the other treatments.

The high density diets, independent of the copper treatments, increased the weights of the hens 173 gm at 16 weeks and the weight of the toms 779 gm at 24 weeks. These increases were statistically significant.

Supplementing copper to 120 ppm significantly increased the weight of the hens 147 gm at 16 weeks and the toms 403 gm at 24 weeks. The weight gains associated with the 60 ppm copper treatment were smaller and statistically overlapped the ranges of both the higher and lower level of copper treatments at the .01 probability level. As shown in table 1, only hens on the LPE diets responded to copper.

Hen livers contained more copper than tom livers in all treatments. High density feed increased the liver copper of hens 3.1 ppm but did not significantly affect liver copper of the toms at 24 weeks.

Supplementing copper at 120 ppm significantly increased the content of copper in hen livers 2.7 ppm at 16 weeks but did not significantly affect liver copper of the toms at 24 weeks. Intermediate values for liver copper were associated with the 60 ppm treatment.

---

[1]Assistant Professor and Professor and Leader, Poultry Research and Extension.

A total of 18 aortic ruptures were observed, 17 were associated with the high density diets, only 1 with the low density diets. In this test, 9, 5 and 4 aortic ruptures were associated with 8 to 12, 60 and 120 ppm copper treatments, respectively.

Table 1. Body Weight of 16-Week-Old Turkeys Fed High and Low Protein-Energy Diets with Three Levels of Copper

Copper	Hens			Toms		
ppm	HPE kg	LPE kg	Avg.	HPE kg	LPE kg	Avg.
8-12	6.275	5.882	6.079a[1]	8.211	7.766	7.973
60	6.266	6.118	6.192ab	8.125	7.821	7.989
120	6.216	6.236	6.226b	8.169	7.879	8.024
Avg.	6.252a	6.079b		8.168a	7.822b	

[1] 137 gm difference significant at P<.01. Values with unlike subscripts are significantly different.

Table 2. Effects of Feeding High and Low Density Diets with Three Levels of Copper to Growing Turkeys

Treatment variable	Market weight: 16 weeks females	Market weight: 24 weeks males
Diet density	kg	kg
High	6.252a[1]	13.557a
Low	6.079b	12.778b
Diet copper	kg	kg
8-12 ppm	6.079a	12.960a
60 ppm	6.192ab	13.107ab
120 ppm	6.226b	13.363b
Copper content of liver	ppm	ppm
High density	20.3a	16.5
Low density	17.2b	14.7
Diet copper		
8-12 ppm	17.3a	14.8
60 ppm	19.0ab	15.3
120 ppm	20.0b	16.8
Aortic ruptures	number	number
High density	--	17
Low density	--	1
Diet copper		
8-12 ppm	--	9
60 ppm	--	5
120 ppm	--	4

[1]Values with unlike subscripts are significantly different at .01 probability level.

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Poultry-Meats Section

A.S. Series 75-36

Egg Yolk Pigmentation with Dehydrated Alfalfa Meal, Pro-Xan and Xanthophyll-free Freeze Dried Alfalfa Juice

E. Guenthner, O. E. Olson and C. W. Carlson[1]

This study concludes a series of tests in which natural and synthetic materials were used to produce deeply pigmented egg yolk. The most efficient pigmenter used was β-apo 8' carotenoic acid ethyl ester followed by β-apo 8' carotenal, alfalfa concentrates and meals of alfalfa, corn gluten and marigold petals. In this test pure lutein, dehydrated alfalfa meal and Pro-Xan, an alfalfa concentrate, were used as sources of pigments[2]. The freeze dried alfalfa juice was tested for its possible effect in enhancing the utilization of pure lutein. Caged hens were depleted of body stored pigments by feeding an essentially pigment free, milo-soy diet for 12 months. Pigmenting materials were then added to the milo-soy basal to provide dietary pigment at levels of 10 and 20 ppm as shown in table 1.

The 17% protein dehydrated alfalfa meal analyzed 322 ppm xanthophyll. The Pro-Xan, a protein-xanthophyll concentrate of alfalfa, contained 40% crude protein and 1067 ppm xanthophyll. The lutein (a common name for xanthophyll) was extracted from the freeze dried alfalfa juice. The residue of the alfalfa juice was fed in diets 5, 6, 7 and 8 at levels equivalent to juice levels. The extracted lutein fed in diets 7, 8, 9 and 10 had a concentration of 6900 ppm.

The concentration of pigment in the egg yolk was chemically determined and expressed as micrograms of β-carotene equivalents (BCE) per gram of yolk. Utilization of the pigment was then calculated from data on feed consumption and weight of egg produced. The test covered a 49-day feeding period, being limited by the amount of lutein that was available.

The BCE values in table 1 show that doubling the amount of pigment in the diet does not double the amount of pigment found in the yolk. The efficiency of utilization decreases as the amount of pigment increases in the diet. This effect has been observed in previous tests. Other factors such as the source of the pigments and the rate of egg production also affect deposition of pigment in the egg yolk.

The concentration of pigment in the yolk from the dehydrated alfalfa more than doubled when the concentration of dietary pigment increased from 10 to 20 ppm. The hens in group 2 were producing at the rate of 34%, while production of the other groups was within the range of 50%. Similar effects have been observed in other tests. Apparently, more pigment accumulates in the yolk when the rate of ovulation declines.

---

[1]Assistant Professor; Professor, Station Biochemistry; and Professor and Leader, Poultry Research and Extension, respectively.

[2]All products were obtained from the Western Regional Laboratories, U.S.D.A., Berkeley, California, through the courtesy of Dr. G. O. Kohler.

There were no significant differences in egg production, efficiency of pigment utilization and yolk BCE values for Pro-Xan, the freeze dried alfalfa juice, the lutein extract or the latter combination. Based on the conditions of this test, xanthophyll utilization from Pro-Xan and lutein would be considered to be superior to that from dehydrated alfalfa.

Table 1. Utilization and Effects of Dehydrated Alfalfa, Pro-Xan and Freeze Dried Alfalfa Juice on Yolk Pigmentation and Egg Production

Treatment[1]	Dietary xanthophyll	Yolk BCE	Utilization efficiency	Hen-day production
	ppm	ppm	%	%
1. Dehydrated alfalfa	10	20.0c[5]	19.0	51.3
2. Dehydrated alfalfa	20	48.0b	14.5	34.4
3. Pro-Xan[2]	10	44.3b	35.9	45.8
4. Pro-Xan	20	70.4a	33.3	51.6
5. F.D. juice[3]	10	0.9c	--	45.6
6. F.D. juice	20	2.7c	--	44.3
7. F.D. + lutein	10	43.8b	43.8	46.3
8. F.D. + lutein	20	63.3a	32.5	52.5
9. Lutein[4]	10	45.8b	43.6	52.9
10. Lutein	20	64.4a	32.9	55.5
11. Basal	--	1.9c	--	43.8
12. Basal	--	0.4c	--	43.6

[1]Basal plus indicated source of pigment.
[2]Alfalfa protein-xanthophyll concentrate.
[3]Freeze dried alfalfa juice.
[4]Crystalline lutein in corn oil.
[5]Values with same subscript not significantly different, P<.05.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-37

Mercury-Selenium Interrelationships in Layers

R. J. Emerick[1], I. S. Palmer[1], C. W. Carlson[2] and R. A. Nelson[2]

Introduction

Results presented in previous Poultry Field Day reports (A.S. Series 73-18, 74-19) have shown 5 to 10 ppm mercury as methylmercury to lower production and reproductive efficiency of hens. Reports from other stations have indicated the existence of a mercury-selenium interrelationship whereby the toxicity of one is reduced by the presence of elevated dietary levels of the other. The studies reported herein were for the purpose of determining the extent that this interrelationship may serve to reduce the detrimental effects of methylmercury or selenium in layers.

Methods

Babcock-300 pullets approximately 24 weeks of age were allotted to nine treatments as shown in table 1. Methylmercuric chloride and sodium selenite were used as sources of mercury and selenium. Each of the mercury-selenium combinations were fed to four cages of four hens each. In each treatment, two of the cages were fed a standard 16% protein layer mash, while the two other cages were fed a semi-purified diet based principally upon glucose, isolated soy protein, vitamins and minerals. Data from the two types of diets are pooled for purposes of calculating treatment averages for this report.

Egg production was measured daily and egg quality measurements were made monthly on a one-day collection of eggs. After 10 weeks on treatment, the hens were inseminated artificially and a maximum of 30 eggs per cage (120 eggs for each of the nine treatments) were incubated. The chicks, upon hatching, were placed in batteries and fed a 20% protein starter diet. Growth and survival of the chicks were measured over a 4-week period.

Results

Average body weight of the hens was lowered in most instances by the selenium treatments and to a lesser extent by mercury. However, mortality occurring during the course of the study did not differ significantly among treatments. Percent hen-day egg production appeared to be reduced by mercury or selenium with mercury

---

[1]Professor of Chemistry and Animal Science, and Professor of Chemistry, respectively.

[2]Professor and Leader, Poultry Research and Extension, and Superintendent, Poultry Research Center, respectively.

exerting the greatest effect. Average hen-day production was 61.7% for the controls and only 36.8% for those fed 10 ppm mercury with no added selenium. Either 4 or 8 ppm of selenium partially prevented the detrimental effect of 10 ppm mercury.

Average egg weights were lower for hens fed mercury or selenium. However, higher Haugh units were often associated with the smaller egg size. Average egg shell thickness was not affected by treatment. These data concerning egg quality differ from those obtained in our previous study in which eggs having thinner shells and lower Haugh units were obtained from hens that had been fed mercury from the time of hatching.

Percent hatchability was lowered by either mercury or selenium alone. Hatchability associated with 10 ppm mercury was only 26% compared with 87% in the controls. Either 4 or 8 ppm dietary selenium fed with the 10 ppm mercury allowed a 56 to 61% hatching rate which was considerably greater than that for mercury alone and was slightly greater than the 50 and 56% observed for 4 and 8 ppm selenium alone. This effect on hatchability is probably the most pronounced of the beneficial interactions observed between mercury and selenium where either one appeared to reduce the toxic effects of the other.

An important interrelationship was also observed concerning the mercury and selenium contents of the various hen tissues at termination of the experiment after 10 months on treatment (table 2). Selenium fed in conjunction with mercury greatly increased the mercury content of some tissues, most notably liver and brain. Corresponding increases in tissue selenium levels associated with mercury treatments occurred in all tissues examined except feathers. It is concluded that, even though tissue levels of these elements, i.e., mercury and selenium, are increased to a greater extent when fed in combination rather than alone, the higher levels accumulated under this condition were associated with a lower degree of toxicity. Whether this is due to a chemical combination rendering each less biologically available to the tissues is a subject of speculation at this time.

Feathers represent a tissue of special interest in that they accumulate very high levels of mercury but relatively low levels of selenium. The high solubility of methylmercury in lipids led to the postulation that mercury in this form may gain access to feathers through the oily uropygial gland secretion used by birds for preening. Subsequent studies on four birds administered methylmercury by i.p. injection failed to show high levels of mercury in either the intact gland or its secretion.

Table 1. Average Production of Hens Fed Natural and Semipurified Diets with Various Combinations of Methylmercury and Selenium

Treatment: Se Level	Treatment: Hg Level	Average body weight	Mortality	Daily feed	Hen-day egg production	Egg weight	Shell thickness	Haugh units	Hatchability
ppm	ppm	kg	%	gm	%	gm	mm		%
0	0	1.20	34.0	115	61.7	63.2	0.335	70.8	87
4	0	1.14	24.5	110	52.6	61.1	0.327	71.0	50
8	0	1.05	13.6	105	50.1	61.3	0.338	71.4	56
0	5	1.17	23.6	105	50.0	58.8	0.348	70.6	61
4	5	1.04	25.8	105	52.7	59.8	0.346	70.4	64
8	5	1.03	29.0	94	41.0	55.3	0.348	75.0	64
0	10	1.10	25.0	105	36.8	56.7	0.347	66.7	26
4	10	1.16	33.6	104	50.7	59.9	0.346	74.2	56
8	10	1.01	20.4	94	46.3	55.0	0.339	75.4	61
Average for natural diet		1.11	29.1	110	63.0	61.3	0.354	68.3	59
Average for purified diet		1.09	21.9	98	35.2	59.4	0.329	75.1	57

Table 2. Hg and Se (ppm) in Body Tissues and Eggs of Hens Fed Natural and Semipurified Diets with Various Combinations of Methylmercury and Selenium

Treatment		Liver		Kidney		Muscle		Brain		Feathers		Eggs	
Se Level	Hg Level	Hg	Se	Hg	Se	Hg	Se	Hg	Se	Hg	Se	Hg	Se
ppm	ppm												
0	0	0.5	0.6	0.8	0.7	0.4	0.3	0.2	0.3	0.3	0.9	0.2	0.4
4	0	0.3	2.4	0.8	1.8	0.2	0.4	0.2	0.5	0.0	2.1	0.1	1.2
8	0	0.4	3.5	1.1	2.7	0.4	0.5	0.4	0.6	0.0	2.2	0.6	1.7
0	5	27.3	2.5	23.4	1.6	10.6	0.4	9.5	0.5	164.6	0.9	10.4	0.4
4	5	51.9	12.5	22.1	3.1	12.0	0.9	13.7	2.7	137.0	2.2	11.0	1.3
8	5	49.3	14.2	20.4	4.3	13.1	1.1	18.3	4.1	140.7	2.5	13.4	1.9
0	10	76.6	3.6	53.1	2.0	22.4	0.4	24.6	0.6	376.6	1.5	19.2	0.4
4	10	99.6	18.7	37.8	4.6	22.0	1.2	30.1	4.5	392.0	1.8	21.9	1.6
8	10	154.3	28.8	43.0	5.3	19.0	1.3	29.6	6.6	319.4	2.1	24.2	2.0
Average for natural diet		52.2	9.4	23.1	3.4	10.8	0.9	15.9	2.9	93.2	2.0	10.2	1.4
Average for purified diet		50.1	9.9	21.9	2.5	11.5	0.5	12.2	1.6	247.0	1.5	12.2	1.1

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-38

Our Studies on Egg Shell Fragility

O. E. Olson, R. A. Nelson and C. W. Carlson[1]

Thin or improperly formed egg shells cause serious losses to our poultry industry, and the problem becomes progressively greater during aging of the laying flock. Therefore, the Animal Science and Chemistry Departments are undertaking work to attempt to understand the causes for greater fragility of the eggs of older laying hens and to reduce the problem by removing or alleviating the causes. Since the work has just begun, no results are yet available. The studies to be undertaken are outlined below.

In the first experiment, three treatments will be used in an effort to bring about a reduction in rate of egg production and thus possibly extend the duration of lay and reduce the production of thin-shelled eggs. Two strains of birds will be used, one known to lay more soft shelled eggs than the other. Treatments include (1) a good diet (16% protein and adequate in all known factors) fed without restriction, (2) the same good diet fed on a restricted basis and (3) a 12% protein diet fed without restriction. Egg production and egg shell quality will be evaluated and several enzyme assays and tissue studies will be conducted in an effort to find some metabolic explanation for egg shell thinning during aging. This experiment is now in about its 30th week and will continue through at least 80 weeks.

In a second experiment, forced molting at various times will be used to interrupt the laying cycle, thus probably extending the duration of lay and reducing the production of poor quality egg shells. Measurements similar to those described for the first experiment will be made.

In a third experiment, Japanese quail will be used to determine the possible effect of uninterrupted egg production on livability. A control group will be allowed to lay without interruption, while a second group will be molted at intervals to interrupt egg production. Egg production, egg shell quality and livability of the birds will be measured, and it is hoped that this and the other studies will aid in developing methods for improved shell quality and possibly provide insights into the problem of aging.

---

[1] Professor of Chemistry; Superintendent, Poultry Research Center; and Professor of Animal Science, respectively.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Poultry-Meats Section

A.S. Series 75-39

Some Effects of Source and Amount of Fat on Serum Cholesterol in Rats

R. A. Nelson and C. W. Carlson[1]

Helping people live longer and healthier lives is the goal of many nutritionists. Indicators have shown that the average American life span increased until 1960 and since then has remained on a plateau. There are even predictions for a decrease between 1975 and 1985, blamed primarily on inactivity, smoking, suboptimal nutrition and pollution.

Most people are concerned about proper nutrition and make serious efforts to be properly nourished; but, what if they are misled? One good case in point is the relationship of dietary cholesterol to serum cholesterol that many persons have assumed. The American Heart Association even admits that their recommendation that everyone limit egg consumption is not based upon scientific study but only upon clinical opinion.

A study with rats partially reported earlier (A.S. Series 74-21) has now been completed. Seventy adult albino rats previously fed a practical diet were divided into seven treatments. Three lipids--corn, egg fat and lard--were fed at levels to provide 20 and 40% of the caloric value of the semipurified diet. Most Americans eat 25 to 40% of their daily caloric intake as fat. A control diet consisted of 2% corn oil with about 5% of its caloric value derived from the fat. The diets were fed in isocaloric amounts each day. The egg fat had been extracted from egg yolk with petroleum ether and therefore contained the egg cholesterol, triglycerides and most of the other egg lipids. Blood samples were taken every 4 weeks and analyzed for serum cholesterol content. After 48 weeks on the test diets, the rats were placed back on a practical diet for a 4-week depletion or leveling-off period.

Some differences in serum cholesterol levels were quite apparent, as shown in table 1. When body weights became somewhat stabilized after 20 weeks (table 2), a sharp rise in serum cholesterol was noticed for all treatments. As the rats grew older, a general increase was observed. An increase in serum cholesterol with age is a normal pattern for humans. In general, no differences occurred due to fat level in the diet. Although the rats on egg diets had higher serum cholesterol levels (about 25 to 30%), feeding twice the amount of cholesterol actually had a somewhat decreasing effect, especially toward the end of the trial. Lard is a fair source of cholesterol but it caused little or no increase in serum levels.

---

[1]Superintendent, Poultry Research Center, and Professor and Leader, Poultry Research and Extension, respectively.

The calculated cholesterol consumption on the average was about 100 mg per day for the 20% calories-from-egg-fat diet and about 200 mg for the 40% diet. The 100 mg for a 1 pound rat that consumes 50 to 60 kcal per day are equivalent to about 30 to 50 eggs per day for the average American male.

In a previous study with 7% of the calories from eggs (A.S. Series 72-12), little effect on serum cholesterol was noted. Therefore, it appears that massive amounts of cholesterol are required to cause an increase in serum levels. Completely removing the nutritious staples--eggs, meat and dairy products--from our diet to reduce cholesterol intake could reduce our intake of minerals, vitamins, fats and essential amino acids to precarious levels. Many of these nutrients are in short supply in the vegetable protein substitutes. A return to good nutrition while maintaining a minimal caloric intake with adequate exercise will prevent many degenerative diseases and allow us to live healthier and longer lives.

Table 1. Effect of Corn Oil, Egg Fat and Lard on Serum Cholesterol of Adult Rats

Week of		Corn oil[1]		Egg fat[1]		Lard[1]		
experiment	Control	20%	40%	20%[2]	40%	20%	40%	Avg.
		mg cholesterol/100 ml blood						
0	99	102	104	106	111	102	102	104
4	109	122	114	123	132	116	126	120
8	99	113	110	122	154	117	126	120
14	122	119	115	129	156	123	138	129
20	145	184	156	214	221	164	158	177
24	138	160	139	208	199	161	146	164
28	157	169	154	233	238	165	172	184
32	143	155	142	214	220	146	152	167
36	149	166	162	257	239	155	166	185
40	159	159	150	310	248	169	162	192
44	189	171	168	271	221	191	170	197
48	197	191	167	333	294	195	205	226
52[3]	170	186	197	238	250	184	194	203
Average	144	154	144	212	206	153	155	

[1]Included in diet to supply the indicated proportion of calories.
[2]The calculated egg cholesterol intake is 100 mg per rat per day. This would be equivalent to about 30 to 50 eggs per day for an adult man.
[3]All rats on the practical diet for last 4-week period.

Table 2. Effect of Corn Oil, Egg Fat and Lard on Weight of Adult Rats (gm)

Week of experiment	Control	Corn oil 20%	Corn oil 40%	Egg fat 20%	Egg fat 40%	Lard 20%	Lard 40%	Avg.
0	382	372	388	381	364	378	378	378
4	404	408	416	400	379	406	402	402
8	408	411	423	407	379	415	414	408
12	402	414	419	399	364	417	413	404
16	422	434	446	429	399	442	437	430
20	418	438	454	431	400	439	436	431
24	446	458	481	463	438	467	461	459
28	457	456	483	461	432	472	464	461
32	467	469	491	470	436	482	474	470
36	472	472	496	480	447	484	480	476
40	479	475	487	470	435	481	477	472
44	465	479	492	479	442	485	480	475
48	470	482	489	479	446	483	486	476
52	515	533	548	534	485	526	524	524
Average	443	450	465	449	418	456	452	

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Poultry-Meats Section

A.S. Series 75-40

Flock Record Summary

Phillip E. Plumart and Boyd J. Bonzer[1]

A computerized flock record keeping system has been in use at South Dakota State University since 1965. A report is computed and published monthly from data received from flockowners. We have usually had 50 to 60 flockowners reporting data. However, in the spring of 1975, participation dropped to about 30 flockowners. The records of those flocks completing their laying cycle during the calendar years of 1969, 1970, 1971, 1972, 1973, 1974 and through June of 1975 are summarized in table 1.

In the past, the figures reported for flocks closed out during the first six months of a year have been remarkably close to the final averages for that year and, hence, seem to be quite indicative as to what the figures for the full year will be.

During the last 6½ years the average laying cycle has varied from 13.02 months in 1973 to 14.07 months during 1974. However, 1969 and 1974 were the same with 13.64 months (415 days).

The average number of hens housed has almost doubled during the last 6 years, increasing from 5,990 in 1969 to 9,872 in 1974. The percent depletion has decreased from 1.12 to 0.75% per month. This reduction seems to have been due to flocks now being vaccinated against Marek's disease. The 1974 depletion of 0.75% per month represents a 40% reduction of the 1970 depletion of 1.25% per month.

Percent hen-day production steadily declined for 6 years from 64.4 to 62.8 and then increased to 65.5 for the first half of 1975. Hen-housed production has varied 58.5 to 60.1 over 6 years with a sudden increase of 2.1% to 61.8% in 1975.

Due to widely fluctuating egg prices, the average income per dozen eggs sold rose from 30.91 cents for those flocks closed in 1969 to 34.74 cents for those closing in 1970. It then dropped to 21.26 cents for those closed in 1972 and rose in 2 years to an all-time high of 46.73 cents for those closed during 1974. The lowest feed cost per dozen eggs of 13.73 cents was attained by those flocks closed out in 1970. The lowest income of 21.26 cents per dozen was received for those flocks closed out in 1972.

The average income per hen housed over feed cost has fluctuated from a low of $1.27 in 1972 to a high of $4.50 for those closed during 1974. The average gross egg income has similarly fluctuated from a low of $37,493 per flock closed in 1969 to $94,884 in 1974.

---

[1]Associate Professor and Extension Poultryman.

Of particular note is the fantastic rise in the feed cost per ton since late 1973. For the flocks closing out during the 4-year period of 1969 through 1972, the feed cost per ton fluctuated between $63.78 and $68.73. The average feed cost per ton has increased 86.0%, from $67.35 for those flocks closing out in 1972 to $125.25 per ton for those closing out in 1975.

Table 1. South Dakota Laying Flock Record Program Summary, Averages for Flocks Closed During 1969, 1970, 1971, 1972, 1973, 1974 and 1975

	40 flocks closed during 1969	45 flocks closed during 1970	47 flocks closed during 1971	48 flocks closed during 1972	58 flocks closed during 1973	47 flocks closed during 1974	19 flocks closed through June 1975
Days from 20 weeks	415	422	404	396	428	415	409
No. of hens housed (HH)	5,990	7,312	7,679	9,302	9,274	9,872	9,404
Percent depletion	15.3	17.3	15.4	14.7	10.9	10.2	11.2
Percent hen-day production (HD)	64.4	64.1	63.6	63.2	63.7	62.8	65.5
Eggs per hen (HD)	268.2	274.6	254.3	248.9	273.6	261.5	267.3
Percent HH production	59.4	58.6	58.6	58.5	60.1	59.7	61.8
Eggs per hen (HH)	247.6	250.8	234.7	230.6	258.6	248.0	252.4
Lb. feed per dozen	4.43	4.21	4.31	4.38	4.39	4.35	4.20
Percent Grade A large	65.35	63.92	63.84	60.93	69.44	71.85	72.46
Percent Grade A medium	18.06	18.54	15.50	15.69	14.12	14.82	14.44
Percent Grade A small	3.07	3.17	2.59	2.55	2.04	1.86	1.99
Percent total Grade A	86.48	85.63	81.92	79.17	85.60	88.53	88.89
Average income per dozen sold (cents)	30.91	34.74	26.18	21.26	29.55	46.73	41.25
Feed cost per dozen (cents)	14.14	13.73	14.82	14.75	17.49	24.70	26.31
Income per HH over feed cost ($)	3.33	4.21	2.16	1.27	2.54	4.50	3.02
Feed cost per ton ($)	63.78	63.80	68.73	67.35	79.61	113.45	125.25
Gross income for period ($)	37,493	51,797	38,912	38,138	58,541	94,884	80,496

WHO'S WHO ON THE PROGRAM

Sherwood O. Berg--Ph.D., President, South Dakota State University

Martin E. Bergeland, DVM--Professor, Veterinary Science Department, South Dakota State University

Boyd J. Bonzer--Extension Poultryman, Animal Science Department, South Dakota State University

Dale Borchard--Dakota Hatchery and Mill, Redfield, South Dakota

Edmund Guenthner--Assistant Professor, Animal Science Department, South Dakota State University

Ali B. Kashani--Graduate Assistant, Animal Science Department, South Dakota State University

Dwight Knutson--Past Producer of the Year, Platte, South Dakota

Marvin Mueller--President, South Dakota Poultry Improvement Association, Mueller's Hatchery, Tripp, South Dakota

Richard A. Nelson--Superintendent, Poultry Research Center, Animal Science Department, South Dakota State University

Oscar Nygaard--South Dakota American Egg Board Liaison, Lakeview Hatchery, Clear Lake, South Dakota

Ralph Palmer, DVM--Veterinarian, South Dakota State Livestock Sanitary Board, Pierre, South Dakota

Phillip E. Plumart--Associate Professor and Extension Poultryman, Animal Science Department, South Dakota State University

Jerry L. Sell--Ph.D., Professor, Animal Science Department, North Dakota State University of Agriculture and Applied Sciences, Fargo, North Dakota

George Semeniuk--Ph.D., Professor Emeritis, Plant Science Department, South Dakota State University

William L. Simpson--Past Poultryman of the Year, Mitchell, South Dakota

Cliff Stewart--Market Area Manager, Shaver Poultry Breeding Farms, Ltd., Des Moines, Iowa

Gerald Weber--Manager, Midwest Egg Producers, Inc., Davenport, Iowa

Seventh Annual
Poultry Field Day
Thursday, November 6, 1975
Staurolite Inn -- Brookings, S. D.
Intersection of U. S. 14 and Interstate 29

10:00 a.m. Registration
Banquet Tickets Available

10:30 a.m. Edmund Guenthner, Presiding

10:35 Changes in the Cost of Egg Production...Phillip E. Plumart
10:55 The Fatty Liver Problem..................Richard A. Nelson
11:15 Low Protein Layer Diets....................Ali B. Kashani
11:35 Moldy Feed -- Good or Bad..................George Semeniuk

12:00 noon
Free Time for Lunch

1:25 p.m. Educational Session
Phillip E. Plumart, Presiding

1:30 Changes in State Egg Law and Regulations....Boyd J. Bonzer
1:45 Replacing Corn with Low Quality Grains for Layers..................................Jerry L. Sell
2:15 Forced Molting -- What Will It Do for You and When Will It Pay?.......................Dale Borchard

2:45 Discussion Period

The Present Status of the Egg Check-Off Bill..Gerald Weber
The Cholesterol Situation..................Oscar Nygaard
Our Pullorum-Typhoid Program.............Dr. Ralph Palmer
The Poultry Disease Picture at the Lab.............................Dr. Martin Bergeland

3:30 Coffee and Cookies

4:00 Annual Business Meeting, SDPIA...Marvin Mueller, President

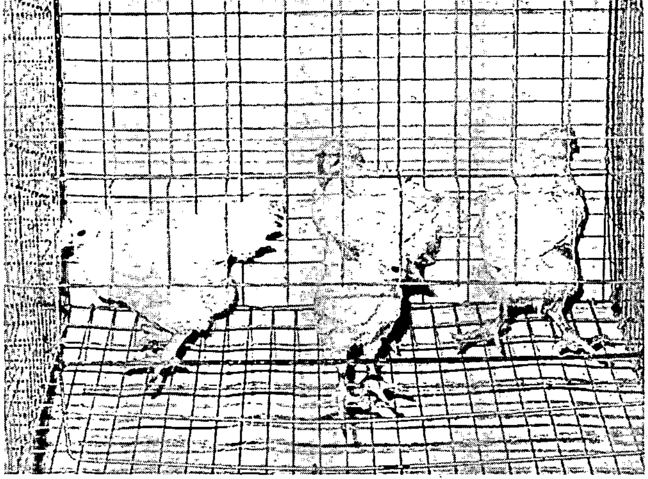
6:30 Annual Banquet and Awards Program

Master of Ceremonies...............................Cliff Stewart
Entertainment
"Can We Feed Them?".............................Sherwood O. Berg
Producer of the Year Award........................Dwight Knutson
Poultryman of the Year award......................William Simpson
Pullorum-Typhoid Clean State award Ray Schar, ARS, USDA

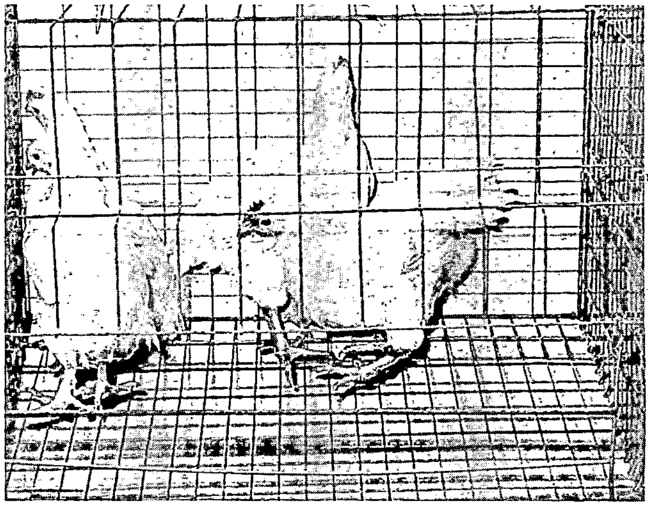
Poultry Research and Extension Section
Department of Animal Science
South Dakota State University
Brookings, South Dakota 57006

Progress in Broiler Feeds
1776—1976

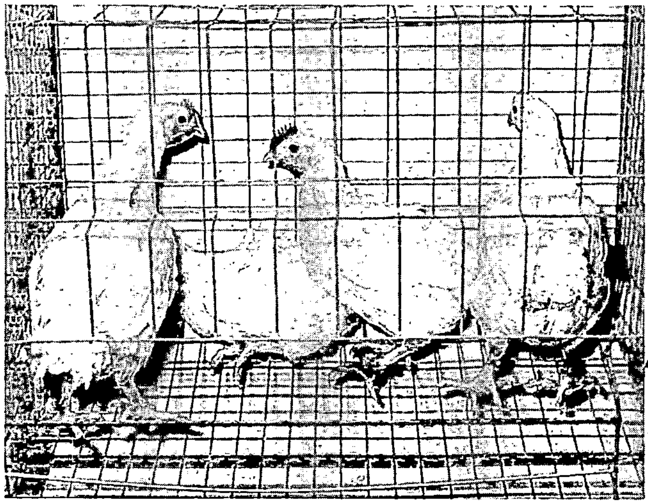
Year	Avg. Wt/Gm 4 wks	Avg. Wt/Gm 8 wks	Feed/Gain
1776	458	1445	3.0
1876	590	1563	2.3
1926	600	1674	2.1
1976	728	2115	1.9



1776—4 weeks



1876—4 weeks



▲ 1926—4 weeks—1976 ▼